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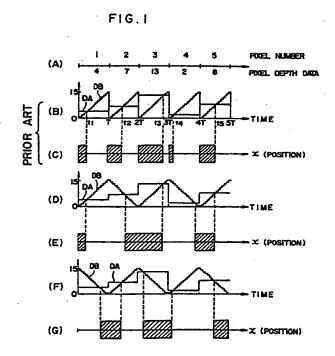
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- Scanning recording type printing method and apparatus for realizing the same.
- (S) A scanning recording type printing method, by which a pixel recroding pulse signal (S) is produced by comparing a comparison data signal (DB), which is formed by repeating an up counting operation and a down counting operation for every pixel, which is the smallest unit region of an image, with a depth data signal (DA) for one scanning line and the location of each of net points of at least one color printed within a pixel is controlled by the pixel recording pulse signal (S) so that worsening of the image quality in a high precision fine image printing can be reduced.



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SCANNING RECORDING TYPE PRINTING METHOD AND APPARATUS FOR REALISING THE SAME is saign, given it the time visites or for

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value mentionerelates to a monochrome or col-repaired control by a recording scanning signal LINE1 from acousting method and an apparatus for realizing the timing treatment circuit 4. 16 clock signals the same and in particular to a scanning recording and some cutivated for a period of time during type printing method and an apparatus for realizing which one pixel domain is scanned for recording. the same epermitting to reduce worsening of the " ... The counter 3 counts up from "0" (white) to "15" image quality in a high precision fine image record- 100% (black) and gives the content of the count as comndebon dinglerop thing that woste with being weithing

5. 10. 18 to 10.

- at the pleacht pixels in corder to express 'light' and shade of the corder to the image in a scanning recording type printing This seal के अक्षाकर apparatus, withere his pknown a method, by which के अ doce mimage recording pulse signals are modulated in 3 means of data representing the C 75% and the adepth. Apparatuses described in Japanese Patent sayona Application/aum-examined apublications Nos. 822 bash to 57679 and 82-99866 are the concrete examples.

In such a printing recording apparatus it is In such a printing recording apparatus it is necessary to reduce each cell in size and increase 20 perates a 2-value pixel recording pulse signal S, the pixel density in order to be able to record an apparatus it is necessary to reduce each cell in size and increase 20 perates a 2-value pixel recording pulse signal S, the pixel density in order to be able to record an apparatus it is s shippinnage: with lachigh precision and a high fineness. The series of the shipping to the scanning direction and the size of each pixel in the state of DA > DB = 10 same of 11, sec or pthe scannings recording are determined by the delid entscanning speed and the production period of the to an a writer if DA S DB ents or been at a notive and unlimage recording pulse signal? Consequently, in orbeanne deroto makes each pixel smaller, the production (180 %) period of the image recording pulse signal must be - poinshortened and the rate of the intermission must be dollar increased. However, when the falle of the intermisand serion of the image recording pulse signal is inels salicreased. The image quality has a tendelice to be nal having a time width proportionberewole depth

pulicipaes oThe reason will be explained concretely taking वार्ष रूवं ani electro-graphic laser beam printer as an examimage recording pulse signal, worsenald of the -nocord and Intrigit 20 at memory device 10 stores depth data and all of reach of the pixels in image signals coming from and primary image aread-out device for a computer (not -อาณุ srishown in the figure) โดง one scanning line. The depth data are sent to a latch 2 in the form of pixel en depth data DA for every pixel, depending on the est dispositions of recording scanning by a pixel clock to bee signal PCLK1 given by a timing treatment circuit 4, en poliwhich will be described later. Supposing that the ban mapixel depth is represented by 16 degrees from "0" (white) to "15" (black), the pixel depth data DA are an area4 bit data. In a pixel recording pulse signal generathe fatch 2 holds (latches) the pixel depth data DA by a pixel clock signal PCEK2 given by the timing treatment circuit 4 and its holding period of time is equal to a period of time during which one pixel domain is scanned for recording. These pixel depth data DA held by the latch 2 are given to a comparator 5. A counter 3 which is a

Counts clock signals coming from a clock generator 10 under the parison data DB to the comparator 5. At the same As:a method for varying the recording area of time it gives a carry signal as pixel clock signal PCLK3 to the timing treatment circuit 4. The timing treatment circuit 4 generates the pixel clock signals PCLK1 and PCLK2, referring to the pixel clock signal PCLK3 and at the same time uses a detection signal LINE2 coming from a laser beam detector 8 as a recording scanning start synchronization signal for every scanning line.

The comparator 5 compares the pixel depth data DA with the comparison data DB and gen-

which is given to a semiconductor laser circuit 6. A laser beam outputted by the semiconductor laser circuit 6 is deflected in a region of an angle θ so as S. 200 3 to scan and illuminate an electro-graphic photosensitive drum 7. in this way an electro-static latent image is formed thereon and transferred to a re--he is a cording paper, after having being developed with toner. After that, it is further fixed so as to be a en cuentas a

Figs. 1(A) to 1(C) indicates a timing chart representing the working mode of the pixel recording pulse signal and the pixel recording in such a laser beam printer. (A) indicates the pixel number and the pixel depth data DA. The abscissa t in (B) represents the time, in which T denotes the period of time necessary for scanning to record one pixel. The coordinate represents digital values corresponding to pixel depths, in which "0" indicates "white"; "15" indicates "black"; DA shows the pixel depth data; and DB shows the comparison data. The abscissa x in (C) represents the position of the recording scanning of the laser beam and hatched regions show the recorded area for each of the

In such a recording method, since the laser beam outputted by the semiconductor laser circuit 6 has a certain spread in the scanning direction, when this laser beam is interrupted by the pixel recording pulse signal S in the course of the scan-

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ning, the light quantity at both the border portions on the pixel recording surface is inconveniently in an intermediate region between white and black and thus the depth of the record at these portions is unstable, what is a factor lowering the image quality. This is produced by the fact that the laser beam has a certain spread. Consequently, when, inorder to record finer image with a high precision, pixels are made smaller and the number of interruptions of the laser beam, is increased, the gives rise to lowering the image quality is a

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sensitive recording apparatuses, in which recording property tion of useless inks. ... scan according sensitive recording apparatuses. electro-static recording apparatuses, and scanning using liquid crystal light switches and light emitting

Teo Pariodes. On the other hand, in the color printing by off-- ୫୭ ରାୟ set printing, it is difficult to position net points (i.e. dots) to be printed with a high precision. For example, in the case of a multi-block printing with 4 blocks of cyan, yellow, magenta and Indian ink, when it is tried to superpose corresponding dots of different blocks on each other, slight misalignment produces Moireé fringes (interference fringes). Therefore, in practice, the screen angles of net points of different blocks are intentionally varied appreciably so that the net points of different colors are superposed at random, in order to prevent the production of low frequency Moiree tringes. However, by this method, superposition of dots of different colors is irregular, what prevents to effect theoretical color correction.

To the contrary, in a digital printer such as a laser beam printer, letc., since it is possible to position fairly precisely dots, even when it is tried to superpose corresponding dots of different blocks on each other, there are produced no Moiree minges.

An article by SAYANAGI published in Denshien Shashin Gakkaishi (Journal of the Electro-Graphic Society) 23, No. 3 (1984) (in Japanese) has disclosed a "concentric solution model", by which the dots are printed by a digital printer so that their centers are superposed on each other (cf. Fig.(3A)) and reported that 100% under color removal -(UCR) is possible by this method (cf. Fig. 3(B). If this concentric solution model could be realized ideally, a perfect UCR (100% UCR) and other various color correction theories would be efficacious. However, this concentric solution model has not taken the following points into consideration.

coording part is signed if the bro

1) Although the dots formed by printing are, in of the recorded dots in the main scanning direction of the recorded dots in the central portion, but they are not precisely printed at the peripheral portion because of scattering of inks or unevenness of printings = According? to Other concentric solution model, since the net points other than the dot of the ink, which is at the top; exhibit their color by their peripheral portion it is difficult to reproduce enthe precise color: up as ംഡെ കന്നും ക

concentric solution model, since arblock net point proportion of such unstable regions increases, what _ ______(dot) by and ndian ink block is at the top, other inks printed under the black net point come to nothing Such phenomena are not limited to the laser , see and in addition; the netopoint (dot) is apt to be beam printer, but produced in common in photo- 10 35 transferred imperfectly because of the superposi-

energy given to recording medium is interrupted and year 13). Even by a digital printer, the net points of and controlled in the course of scanning, stylus TO THE TARTHER DECAUSE Of expansion or contraction of paper, recording type recording apparatuses such as a set of the concentric solution model is poor at this scanning illumination type electro-graphic printers _____ so position divergence and the risk that Moireé fringes celoare are seed is high: 636-96-55 bas 6"975

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The density in order to be able to record an a ebivora totesimoitnevinh sielt clar teelele entligh tineness. ni resig iscanning recording type printing method and an ent vo apparatus for realizing the same permitting to reant to being weisening of the image quality in the high and the controlling the controlling the noticulocation of get points of at-least one color printed period of the image recording-lexige shiftly must be

ed taum noi Accordingate ithis invention, in a scanning reninceutaraqqta garibaraparidainga eqyte gailgaentermis--ni35; depth data of each of the pixels in the image signal ed of orang-transformed into an image recording pulse signal having a time width proportional to the depth priviles viorgeach of the pixels and production of recording muxe renergy is controlled so as to be interrupted by this image recording pulse signal, worsening of the such the image quality is reduced by reducing the proporpulling of the area of unstable regions a shat is, this ne invention is characterized in that, by producing the rear end of the recording pulse signal of the pree45 ceding recording side pixels in autpaired pixels ent no adjacentato an arbitrarily selected spixely in the retoolo liggrding scanning direction in accordance with the a must rear end of the relevant-pixel and the front end of entinenthe recording pulse signal tofe the succeeding re-- so me cording side pixel in accordance with the front end and Ag of the relevant pixel so that the production of the energy recording energy between this pairs of pixels is Exiq scontinuous and by making the region, where the vio grecording depth is unstable, smaller, worsening of

. 55 the image quality is reduced. Entire and you ganua emil to coaled a calebas at emil to cahed prubinoper not be ment at the nob learly end notifier These pact doubt the DA to 1 of the two 2 are and professional community of a contraction of the fig

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and the smallest contact hand, the "pixel" is the smallest कार्य करा unit of spatial resolving power, when an original 部件: Canalogue: image is quantized (digitalized) and in ent vi Ugeneral it is defined so as to be sufficiently small. printer in line audigital printer, however many net points are balate of formed in this pixel and wherever the net points are also be written in this pixel, no differences therebetween eth or beannot be recognized by human eye. In other boat bet if the met within a pixel, wherever the net points are and imoved, the movement itself doesn't lower the resolving power. For example, in the case where a pixel sis large, the Bayer method is adopted, by and a which one pixel is represented by many small net points (dots), or a net-point is formed at a position (0.13) ent to i deviated from the center of the pixel in order to A 150 militave asscreen angle Also according to this invenscreet tions attention is paid to this point and in full color and a printing by multi-block printing, the net points a hand (dots) of each of the colors formed within one pixel 1. The are not concentrated to one point; which is the new 20 to a sericenter of the coixely contrarily to those in the con-- poli-greentific asolution amodel abutathey fare suitably ar- ear arm son at a construction of a prior art laser beam printer. assimsuperposition of the net points of different colors isngia i canobercontrolled and asothe result a high quality nois' afull color printing can be effected කටා වේ?

nois' afull color printing carebe effected.

Socio lexiq That is, ithis invention is characterized in that, printing explaining the prior art techniques; alexid and recitwhen and intermediate chrominance is printed by io as leffecting varea-modulation depending on a plurality emocecof colored inks within a bixel, which is the smallest of beliqunit region of spatially quantized image data, an isnime area-modulation is reflected by larranging a first of to recolored ink of at least one color at a first position

within the pertinent pixel and another area modula-ടൊന്നാ tion / isceffected by arranging a second colored ink is the first of at least one color, which is different from the first the all a colored rink; tathas second position within the perricelo stinent pixel, which is different from the first position. uns 31 notation arpreferred embodiment according to this invention, the first colored ink mentioned above is arranged from one end within the pixel towards the still is center of the spixel and the second colored ink mentioned above is arranged from another end Light swithins the pixel towards the center of the pixel.

- section with another preferred embodiment according to ed to this invention, the one end and the another end stated above are one end and the other end in the a bas main scanning direction within the pixel.

ा १६ ७० ांnestill another preferred embodiment according to this invention, the first colored ink stated above seconstituted by a multi-layer structure consisting of yellow ink, magenta inkland cyan inkland the second colored link stated above is constituted by they au**black ink.** Isagia fuctor and it. Tevel teams wal

ार्थक का In still another preferred embodiment according to this invention, in an arbitrarily selected pixel the first colored ink mentioned above is arranged from modes one end within the pixel towards the center of the

pixel and the second colored ink mentioned above is arranged from another end within the pixel towards the center of the pixel, and further in pixels rio gni adjacent to the arbitrarily selected pixel mentioned above the first colored ink is arranged from the another end within the pixel towards the center of the pixel and the second colored ink is arranged from the one end with the pixel towards the center of the pixel."

BRIEF DESCRIPTION OF THE DRAWINGS

Figs. 1 (A) -(G) represent a timing chart for explaining the working mode; (A) indicating pixel numbers and pixel denth data; (B) and (C) the working mode for production of the pixel recording pulse signal and the pixel recording pattern according to prior art techniques; (D) -(G) the working DW 507 mode for production of the pixel recording pulse signal and the pixel recording pattern by the method according to this invention.

Fig. 2 is a block diagram illustrating the con-

Figs. 3 (C) and (D) are schemes for explaining the principle of this invention in color printing, and 5 .2V

Son data production circuit for realizing this invenars noit in or

Figs. 5 (H) -(P) are schemes for explaining the อมอัยกอตุ กิลิยิ working mode for production of the pixel recording pulse signal and the pixel recording pattern by means of the circuit indicated in Fig. 4;

Fig. 6 shows graphs indicating more in detail the embodiment of this invention indicated in Fig. 3

Fig. 7 is a block diagram indicating, a circuit for obtaining the pixel recording pattern according to an embodiment of this invention;

an embodiment up the working in Fig. 8 shows graphs for explaining the working mode of the circuit indicated in-Fig. 7;

Figs. 9 -11 show embodiments in the case ent ne distance the position of dots is controlled not only in the main scanning direction but also in the auxiliary scanning direction, indicating the position of dots, information given to the printer and the dot pattern recorded by printing, respectively;

S. 164 Fig. 12 is a block diagram indicating the con-50 E struction of a circuit, which is another embodiment of this invention; eum in

Fig. 13 is a block diagram indicating the construction of a circuit, which is still another embodiment of this invention; and

Fig. 14 is a scheme for explaining the principle of the circuit indicated in Fig. 13.

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DESCRIPTION OF THE PREFERRED EMBODI- A STATE of Fig. 4, a counter 13 is a hexadecimal counter to the preferred by the state of the stat evada be MENTS to represe met bevishe di

Figs. 1 (D); (E) and (F), (G) are iming chart illustrating the working mode of the production of the pixel recording pulse signal and the pixel recording according to this invention.

क्षात्वा पुजर (D) shows the working mode of the production THE of the pixel recording pulse signal using the comof production of the pixel recording pulse signal S the odd pixel number regions the front end of the CURYON rear and of the pertinent pixel, i.e. the rear end of the recorded dot in the main scanning direction and thus in the example indicated in the figure the pixels No. 2 and No. 3, and No. 4 and No. 5 become continuous. Consequently, in the recording pixels recorded on the basis of this pixel recording pulse signal, as indicated in (E), the pixels No. 2 -navni si and No. 3, land No. 4 and No. 5 are continuous, respectively, and thus there are no border portions and the scanning direction between the pixels belonging to each of the pairs. Therefore the unstable

(F) shows an example, where the magnitude of the comparison data DB decreases in the odd pixel number regions and increases in the even pixel number regions. In the recording pixels of this case, as indicated in (G), the pixels No. 1 and No. 2, and No. 3 and No. 4 are continuous.

Now the pixel recording pulse signal producow tion circuit used for such a pixel recording will be explained. The production of the pixel recording pulse signal by the comparison between the pixel depth data DA and the comparison data DB, as previously indicated in Fig. 1(D) can be effected by ameliorating the circuit generating the comparison data DB indicated in Fig. 2. Therefore, here this circuit generating the comparison data DB will be explained and explanation of the other circuits will be omitted, because they are identical to those used in prior art apparatuses. Further each of output terminals of each of the circuits and the signal produced there are denoted with a same reference buz must out air profits are rolled and a file

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the diagram in page edit

ter, which counts clock signals CLK1 inputted from a clock generator 10 to its clock terminal CLK. The recording scanning signal LINE1 outputted by the timing treatment-circuit 4 is at the high level during the recording scanning. The counter 13 stated above secunts: the clock signals CLK1; when this recording scanning signal LINE1 inputted to the - clear terminal CLR is at the high levelwand it is parison between pixel depth data DA and compari-.e. 100 cleared to 000 when the signal LINE1 is at the low son data QB in which the magnitude of the comparison data DB varies so that it increases in the beginneutted as it is to an input terminal A of a data odd pixel number regions, and decreases in the $y_0 \times y_2$ y_3 y_4 and the reversed value refirthe output even pixel number regions. In this way, the position regional Qualis, inputted to another input terminal B 15 no thereof. That is, when the output signal Q of the generated by comparing the pixel depth data DA _____counter 3, 20" is inputted to the input terminal A entitices with the comparison data is so determined that in was and 1715 to the input terminal Ba This data selector atomic, 14 outputs the input signal selectively at one of the pixel recording pulse signal is in accordance with property terminals A and B stated above; depending the front end of the pertinent pixel and in the even enter the signal level inputted to its selection control pixel number regions the rear end of the pixel recording purse signal S is in accordance with the rear end of the pixel recording purse signal S is in accordance with the recording purse signal O is of an RS-flip-flop-YOW SIN (hereinbelow, abbreviated to FF) 125 As latch 15 and a mount structure of the second structure of the second secon viiss, asatis from its output terminal as: the output signal (Q₁₅ (comparison data DB) and effects data latch, pertini depending on the signal level of the pixel clock vo pernaignal given to its enable terminal Encil Further the villarulo carry signal eutputted to the carry terminal Car of In: 30 ms the counter of stated above is reversed to become

> CLK of EF 12 and to the enable terminal En of the position within the pertinent pixel and another 15th modulabedissebutionio-entit to noithware setting colorection 12117 and above when the recording scanning signal LINE1 enputputted from the timing treatment circuit 4 is at Acoli ettestnuce 6th pelnuce entre level, develore to strong side of signals CLK1 given by the clock generator 10 and a 49 vod increases the value of the counting output signal enti abra When the value of the counting output signal an bonQ reaches 15", a party signal is produced at the bre recarry terminal Carn When the data selector 14 is leset at the initial state so that the signal at the input 345 no terminal A is selected to be outputted, the comparione reson data DB which are the output signals Q's of the car ni platch, 15 iggreases successively from 50% to "15". When the value of the count reaches 115th and a

> ns stabithe pixel clecks signal PGLK3 cwhich is supplied to

the timing treatment circuit to to the clocksterminal

pub.occarry signal Cartis outputted the lattentis given to 50 the enable terminal En of the latch 15 as the pixel clock signal RCLK3 and the datch 15 stated above en be latches 15 Since the pixel clock signal PCLK3 is vil bei given also to the FF-12, the FF-12 is inverted and the signal level of its output signal Q12 is changed. By this change of the signal level of the outout signal Que the data selector 14 selects the signal at the input signal B and outputs a signal at its output entries terminal Y., Consequently, the value at, the output

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-ion a terminal Y of the data selector 14 varies from "15" ed aso to 70", but since the latch 15 latches "15", the on comparison data DB remains to be "15". The above is the signal treatment for the pixel of pixel number 1. When the succeeding clock signal CLK1 is inputted, the content of the counter 13 becomes Consequently the value at the output terminal Y of the data selector 14 becomes "15" and the signal treatment proceeds to the treatment for the pixel of pixel number 2. At the same time the carry signal Car of the counter 13 disappears and therefore the latch 15 outputs the signal at the input terminal Das it is. After that the counter 13 counts the clock signals CLK1 and its content increases. However, since the data selector 14 outputs the value at the terminal B, to which the reversed signal is inputted, the comparison data DB, which is the output signal Q of the latch 15, decreases Y Successively: When the content of the counter 13 reacties "15" (comparison data DB = 0), a carry signal Car is outputted and thus the latch 15, the FF 12 and the data selector 14 are controlled in the Same way as stated above. At this time the data st selector 14 is so commuted that the signal at the input terminal A is selected and outputted at the output terminal Y. . 4400s benis axe

The comparison data DB repeats its increase to noseand decrease, as indicated in Fig. 1(D), by the fact that such operations are repeated in a period of time, during which the recording scanning signal cas cleuned is at the high level.

as or beliefuch a comparison data production circuit has an advantage that a high speed operation is possito the with respect to the case where the counter 13 to the counts up and down.

Then it is possible to obtain the pixel recording pulse signal for effecting the pixel recording, as indicated in Fig. 1(E), while comparing the magent an nitude of the comparison data DB thus obtained with that of the pixel depth data DA.

miv soneb in addition, when the output signal Qp of the FF 12 is initialized so that in the initial state the data selector 14 selects and outputs the signal at the input terminal B, the comparison data DB varrecording pulse signal S, which effects pixel recording, as indicated in Fig. 1(G), can be obtained.

Furthermore, the comparison data production circuit indicated in Fig. 4 is provided further with a counter 11 and a monostable multi-vibrator -(hereinbelow abbreviated to MM), 16 (block indicated by a broken line). It is possible to vary the screen angle. When a recording operation begins, the timing treatment circuit 4 outputs a high level signal and when the operation is terminated, an printing signal PAGE is produced. The counter 11 is a 2-bit binary counter, in which, when its counting value reaches 3, the carry signal Car becomes high, and screen angle data SD are loaded, when the printing signal PAGE is low. When the carry signal Car of the counter 11 is low, the FF 12 is preset. As the result, since the data selector 14 selects and outputs the signal at the input A the initial value of the comparison data DB is "0". To the contrary, when the carry signal Car is high, the FF 12 is cleared. As the result, since the data selector 14 selects and outputs the signal at the input B, the initial value of the comparison data DB 10 e is "15".

When the recording of one scanning line is terminated, the recording scanning signal LINE1 becomes low, the counter 11 counts up. In the case where the counting value of the counter 11 varies as "0" - "1" "1" - "2", since the carry signal Car remains low, when the recording scanning signal LINE1 is changed to the low level and the MM 16 is triggered so that a short pulse signal is produced at its output terminal Q., this pulse signal Q is given to the clear terminal CLR of the FF 12, which is therefore cleared. In the case where the counting value of the counter 11 varies en is en or a second of the carry signal Car is changed to the high level and thus the pulse signal Q., generated by the MM 16 is given to the preset terminal PR of the FF 12, which is therefore preset. Further, an the case where the counting value of the counter on 11 is 3 and the carry signal Car is at the high level, since the load terminal L of the counter 11 is at the low level, the following counting value of the counter 11 is screen angle data SD. Consequently, when the screen angle data SD is 33, the FF 12 is preset and when it is not, the FF 12 is reset. This 35 operation is continued as far as the recording is terminated and the printing signal PAGE becomes

of probabilities in since the control of the street of probabilities in the street of operation of production of the pixel recording pulse signal S controlled by this circuit and the pixel recording, in which (H) and (I) represent a case where the screen angle data SD are "3", (H) showing the operation of production of the pixel recording pulse signal, (1) illustrating a pixel recording ง ขอยมะ 45 pattern by means of the pixel recording pulse signal, which is obtained as the result of the operation indicated in (I). The abscissa corresponds to the recording scanning direction, where it represents the time in (H) and the scanning position in (I), but it is indicated here by the pixel number. The ordinate corresponds to the direction, along which the recording medium is sent, in which it reprener sents the time in (H) and the transfer amount in (I), but it is indicated here by the scanning line number. Further, for the ordinate, the counting value of the counter 11 is written together therewith. (J) and

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(K) show the case where the screen angle data SD (K) show the case where the screen angle data SD are "1", and (M) and (O) the case where the screen angle data SD are "0".

In the case where the screen angle data SD are "0".

are "3", since the counting value of the counter 11 is always "3" as indicated in Fig. 5 (H) and thus the carry signal Car of the counter 11 is always at the high level, the FF 12 is preset every time the comes low. Consequently the initial value of the comparison data DB for every scanning line is "15" and the same operation of production of the pixel recording pulse signal as indicated in Fig.1(F) is repeated. As the result the pixel recording pattern for each of the scanning lines based on the pixel recording pulse signal thus obtained is such that the pixels of pixel numbers 1 and 2, and 3 and 4

are continuous, as indicated in Fig. 5(1). are "2", since the counting value of the counter 11 varies in the order of the scanning line number "2", 933 * "3", "2", "3", ..., as indicated in Fig. 5(J), the carry signal Car of the counter 11 repeats to be at the of paparable and high levels alternately and therefore the initial value of the PF 12 for each of the scanning lines is alternately "clear", "preset", "Clear", ... in quently the initial value of the comparison data DB the scanning line scanning lines is "0", when the scanning line number is odd, and "15", when the scanning line number is even. As the result the same operations of production of the pixel recording pulse signal as indicated in Figs. 1 (D) and (F), respectively, are alternately repeated. Consequentan look number, as indicated in Fig. 5(K), pixels of pixel numbers 2 and 3, 4 and 5 form pairs and their pixel_recording is Continuous. To the contrary, for the scanning line having an even number, the pixel recording of the pixels number 1 and 2, 3 and 4 is continuous.

fin the case where the screen angle data SD are "1", the counting value of the counter 11 repeats a same pattern as "1". "2", "3" "1", "2", "3" S(L) as indicated in Fig. 5(L) Consequently, since the initial value of the comparison data DB on for each of the scanning lines repeats "0", "0", #15" in the order of the scanning line humber, The pixel recording pattern is such that it is indicated in Fig. 5(M). .ns

The case where the screen angle data SD are "0", the counting value of the counter 11 is represented by a repetition of "0", "i "9" 2", "3". Consequently, since the initial value of the comparison data DB repeats "0", "0", "0", "15", ... in the order of the scanning line number, the pixel recording pattern is such that it is indicated in Fig. 5(P).

Comparing the pixel recording patterns indicated in Figs. 5 (I), (K) (M) and (P), it can be understood that the screen angle of the recording pattern varies depending on the value of the screen angle data SD, in a full color laser beam printer by multiple printing when the screen angles of different colors are identical, Moireé fringes are produced and the image quality is lowered. Consequently, in the case of such a color printing, it is possible to obtain a high quality color image without Moireé fringe by varying the value of the screen angle data SD for every color-

51 the embodiment described above, increase or decrease in the number of bits in the pixel depth data DA, the comparison data DB and the screen angle data SD, modifications in the waveform of the comparison data DB, e.g. modification into a form permitting to compensate y characteristics of the \$-55.50° printer, and further modifications of the method, by 20 which the value of the screen angle data SD is set, are freely chosen benutive at the mornie

en ni bellonit is obvious that this invention can be applied scanning recording type printing recording devices

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As explained above, according to this invenessecution, since in a pixel recording pulse signal generaton entition method by which depth data DA of each of to point pixels in an image signal are transformed into an image recording pulse signal having a time width proportional to the depth for each of the pixels and of recording strong as the production of recording strong as controlled so as to be interrupted by the image recording pulse signal, the recording pulse signal is so produced that the rear end of the recording pulse signal of the preceding recording side pixel in a pair of enterious: lead an inspector simpled in the same and serious selected pixel in the The service of the se -psm the rear end of the arbitrarily selected pixel and the tront end of the recording pulse signal of the succeeding recording side pixel is in accordance with the front end of the arbitrarily selected pixel, production of recording energy, is continuous between the pixels of these pairs, that is, the ratio of the areas of the unstable regions stated above can be areas of the unstable regions stated above can be reduced so that the factor lowering the image quality produced by interruptions of the recording enbeniete so near the image quality are ric Trade alleviated.

so Figs. 3 (C) and (D) are schemes illustrating the principle of 100% UCR according to this invention.

Fig. 3(A) indicates a cross-sectional view of a structure, where yellow jnk Y, magenta ink M and Cyan ink C are printed in this order on a white paper sheet concentrically at a net point so that they are superposed on each other. A. A sign in Fig. 3 indicates a boundary between two adjacent pixels. Fig. 3(B) indicates the same structure, for

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which, 100% UCR is effected according to the model. As indicated in the figwhere the three colors, yellow, a magenta and cyan are superposed on each other so as to represent black points, are replaced by net points formed by black ink, Consequently, in the case where the net points (dots) of the three colors have a same size as the fourth pixel from the left, and the pareal image. The same size as the fourth pixel from the left, and the pareal image. since they can be represented only by black net points (dots), there is no color shear in printing due to superposition of different colored inks and further the amount of used colored inks is relatively small.

Fig. 3(C) illustrates an example, in which 190% UCR is effected according to this invention. In this example, colored dets such as yellow, magenta; cyan, etc. are put to the left within the pixel and only black dots are put to the right. When dots are printed in this way, the black dots and colored ones are not superposed on each other by calculation of 100% UCR. Consequently there are no colored inks, which have been used in vain under a black dots in the concentric solution model and the number of colored inks superposed on each other at a dot is at most 2, what reduces transfer defectives.

Furthermore, when colored dots are put to the left side corresponding to one end of the pixel in the scanning direction for the first pixel (from the left); the black dot is put to the right side corresponding to the other end of the pixel in the scanning direction; to the contrary, for the second pixel adjacent to the first pixel, the black dot is put to the left side and the colored dots are put to the right and so forth, that is, the position of the colored dots and that of the black dot are replaced alternately for every pixel, as indicated in Fig. 3(D), dots in two pixels adjacent to each other can beput together.

> When they are printed in this way, they be- 2246 come larger in appearance and thus the central portion of the uots can be used with a higher efficiency. Further, at the same time, in this manner, since printing becomes less sensitive to shear. of different colors in printing, it is possible to realize a color reproduction with a high fidelity having no Moireé fringes. 1 .. H J

Fig. 6 shows top views of the surface of the paper sheet for the embodiment of this invention indicated in Fig. 3(D). Fig 3(D) is reproduced at the first line of Fig. 6.

The first pixel is divided-from the left of the pixel into four parts, i.e. a part printed double with cyan ink and yellow ink, a part printed only with cyan ink, a blanc part and a part printed only with black ink. Since the second pixel begins from the left by a black part, the black part of the first pixel and that of the second pixel are jointed together.

and colored that black parts and colored no ACpaids are arranged afternately. When this procedure measurement is changed also for every line as sindicated in the figure, the whole print is equivalent 55 4 in appearance to a dot printing having a screen angle of 45°. The 5-th and 6-th lines in Fig. 6 a gillustrate a formation of dots, which is closer to the

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35 1 85 1 Fig. 7 is a block diagram showing the construction of a circuit, for which the embodiment of this invention indicated in Fig. 3(D) to a digital printer scanned continuously in the horizontal direction as in a television and Fig. 8 shows schemes for explaining its working mode. In Fig. 7 equivalent or identical items are represented by the same reference numerals as those used for the circuits indicated in Figs. 2 and 4.

For explaining Figs. 7 and 8 more concretely, $^{\mathbb{C}}$ the depth of the data DA allocated to each of the pixels of an image is represented by using e.g. a 3-bit number from "0" to "7". Consequently intermediate tones can be indicated by intermediate values among 8. An octal binary counter 13 and a pixel address counter of the frame memory 1, in 25 - which pixel data DA are stored, are cleared by the line synchronization signal LINE of a digital printer (e.g. laser beam printer, thermal head printer, ink ve he rejet printeraliquid crystal printer semiconductor la-* A the ser printer, light-emitting diode printer) 77. At the euso : same time the flip-flop (hereinbelow abbreviated to of each FE) (12, is set or preset depending on the phase 8 809/8 data Car (cf.º:Fig.4)...:The counter 13 counts the reference clock CLK coming from a clock oscillator 10 so that its output increases starting from "0". 35 When the output of the FF 12 is low, the data selector 14 outputs the output of the counter 13 as it is as the comparison data DB, and when it is high, the data selector 14 outputs the reversed value of the output of the counter 13 as the comparison data DB. Consequently, when the output of the FF 12 is low, the comparison data DB increase from "0" to "7" and when it is high, the companson data DB decreases from "7" to "0". When the content of the counter 13 has reached "7" and returned again to "0", the most significant bit MSB of the output of the counter 13 falls. Responding thereto, the memory 1 outputs the following pixel data and at the same time the FF 12 is reversed. Since the selector 14 reverses the comparison data by the reverse of the FF 12, as the result the comparison data DB begin with "0", when the phase data FD is "low", and go and return between "0" and "7". Therefore, they are such that they are indicated in Fig. 8(A). Further, when the FD are "high", they begin with "7" and go and return between "0" and "7". Therefore, they are such that they indicated in Figs. 8 (B) and (C). On the other hand the pixel data DA outputted by the memory 1

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hereign trare inputted in the comparator 5, where it is judged and enulations which are larger, the inputted pixel databDA or the or Established There are stwo fludgement malevi in outputs of the comparator 5. One of them is "high", if DA < DB, and the other is "high osifoDA > DB. De Only the platter is reversed so as topbe a signal ad the representing DA ≤ DB and both the signals are inputted in a data selector 73. The most significant. bit (MSB) of the pixel data DA is used as a selec-: -ta Tt ::

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tion signal in the selector 73, which outputs a signal, which is "high" If DA & DB for the DA from "0" to "3", and if DA" < DB for the DA from "4" to "7". When this signal is imputted in a printer 77, supposing that a black point is printed, if the VD is high and a white point is printed, if the VD is low, the area ratio S of the black part printed within one pixel varies as indicated in the following table and intermediate tone printing can be effected. au nonarmo ni ruoniz no lui el el enti na lui i

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ent mention is adapted to the image data in the circuit - oso eblaccording to this invention at the sacrifice of S =

erti ot 1/2, a printing indicated in Fig. 6 can be effected.

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illustrates the recording result. The type information

This circuit needs no memory such as pattern generator, etc. and its construction is simple and fitfor high speed operation. In addition, since the number of modulations of the area modulation is 2º, as indicated in Table 1, it is easy to combine it with the multi-value Dither method or the multivalue depth pattern method.

Furthermore, although the position of the dots printed within a pixel has been shifted to the left or to the right (in the main scanning direction x), the same effects can be obtained, also when they are shifted in the up-and-down direction (in the auxiliary direction y) or when they are shifted both in the left-and-right and up-and-down directions (in the main scanning direction x and the auxiliary 1 15 scanning direction y). An embodiment in this case will be explained below, referring to Figs. 9 to 11.

This invention can be applied to a case where a printer is used, which can control the position of dots area-modulated and printed within a pixel not only in the main scanning direction x but also in the auxiliary scanning direction y. Fig. 9 is a scheme for explaining how dots are arranged in pixels (not visible) allocated on the surface of a paper sheet. Four types of dot positions, A, B, C and D are conceivable on the basis of assumptions of a printer. In Fig. 9, there are five sorts of pixel data, i.e. from "0" to "4", which are depth data allocated to the pixels. "0" represents "white" prists and 4% "black (all over) "To the contrary "1" "3" man perceptesent half tones between them? In the type A. ed asother dot enlarges distarting from the up and right -cases cornerain the pixel with increasing pixel data. In the who htypes: By Crand Dethe dot enlarges, starting from the up and left comer, the down and left comer and Additions the downward the right printer receives the pixel able adata and information on the type, which are then recorded, as indicated in Fig. 9. Fig. 10-indicates information given to the printer for every pixel, in the case where the pixel data and the information west thus received are recorded in practice; and Fig. 11

or after a right. It is consider to suggestions for one victions were been earliered wheek, saved Remainer by infing teamhiby the nothing partial of a semi-colon criming bushiness ent of subtilised the issues the itside into as beginned. Here has an ediese but he reary queller i analyslast simil redoction to more income activities to

indicating the dot position within the pixel is given alternately for every pixel, such as A, B, A, B,, for the first line, as indicated in Fig. 10, and alternately for every pixel, such as D, C, D, C, ... for the second line. Further, on and after the third line. the type information for the first line and that for the second line are given alternately and repeatedly. As the pixel data arbitrary information of "0" -*4" is allocated to each of the pixels and this figure shows an example thereof. The result obtained by recording on a paper sheet is such that it is indicated in Fig. 11, where four dots in four pixels, two adjacent pixels in the vertical direction and two adjacent pixels in the horizontal direction, are printed, as if they were gathered together at the centre so as to be one point.

According to this embodiment, the number of dots is reduced to 1/4 without lowering the resolving power between different pixels. That is, the ratio of area of the unstable region stated above is lowered and the worsening of the image quality is alleviated.

Fig. 12 is a block diagram illustrating the construction of still another apparatus for realizing the method according to this invention. The difference from the apparatus indicated in Fig. 7 consists in that the apparatus indicated in Fig. 12 is constructed by using a look up table memory 79 and a shift register 70 contrarily to that a data selector 14 and a comparator 5 are used in the apparatus indicated in Fig. 7. The memory 79 outputs an output pattern on the basis of the pixel data DA sent by the frame memory 1 and in-pixel phase 105**35** 20 data DFD sent by the flip-flop 12. The shift register 70 transforms it with a high speed by a parallelserial transformation to form a video signal VDS. When the look up table is defined as follows, the apparatus works in the completely same manner as the apparatus indicated in Fig. 7.

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E bas of your em enter the look up table memory 79 used in this embodiment receives image data of 12 bits in total from the frame memories 1 yan, c and 1 storing yellow, magenta, cyan and black data, respectively, and receives also selection signals S. S. for selecting necessary video signals and in-pixel phase data PFD, which can be expanded so that an optimum in-pixel net point arrangement can be calculated. In this case, since the position of the dot in each of the pixels can be set arbitrarily, applications as indicated below are conceivable

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Net point printing expresses, in general, colors by addition color mixing and subtraction color mixing and in general, their ratio cannot be determined unequivocally, even when a same color is expressed.

For example, in the case where red having a reduced chromaticity is expressed, it can be obtained not by superposing two colors but by juxaposing them, as indicated in Fig. 14A, where magenta is put in the left half and yellow is put in the right half. However it can be obtained also by superposing the two colors, magenta and yellow, in the left half region. The former represents an addition color mixing of magenta and yellow and the latter represents a subtraction color mixing of magenta and yellow. Of course an intermediate color mixing between them can be conceived. According to the method of this invention it is possible to vary

* 20 * rarbitrarily the cratio of these addition color mixing A boy and subtraction color-mixing. Either the subtraction whom the golder mixing cor the haddition; color mixing than be ent a sbetter, depending on used inks. Therefore by manmon pripulating suitably this tatle of the subtraction color 2013 1911 Thixing and the addition color mixing by means of lexic sthise apparatusarit is possible for inks to exhibit ner expetter their color expressivity and therefore a wide restablished spice of the spirit spir

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exid valAs explained above; according to this inven-40 tion, since the position of the dot ear very color the printed within a pixel can be shifted up and down or left and right, it is possible to superpose inks ideally, time inks are used more usefully and saved. Furthermore, by unifying reasonably net points (dots) of a same color, printing becomes stronger against shear, and as the result this invention has an effect that the image quality is ameliorated in the reproduction of full color images.

Claims

1. A scanning recording type printing method. in which an image is printed by area-modulating the interior of each of pixels, which is the smallest unit region of an image, by means of ink of at least one color, comprising:

1- Fig. 12 of ora-

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a step of bringing the ends of the pixel in predertermined directions (x, y) and the ends of a dot formed by said ink recorded within said pixel in accordance with each other; and

a step of bringing the front end of the pixel succeeding said pixel in said directions (x, y) and the front end of a dot formed by said ink recorded within said succeeding pixel in accordance with each other.

- A scanning recording type printing method according to Claim 1, in which one of said preidetermined directions is the main scanning direction (x).
 - 3. A scanning recording type printing method according to Claim 1, in which the other of said predetermined directions is the auxiliary scanning direction (y), which is substantially perpendicular to said main scanning direction (x).
- 4. In a pixel recording pulse signal generation method, by which depth data (DA) of each of pixels in an image signal are transformed into an image recording pulse signal (S) having a time width proportional to the depth for each of the pixels and production of recording energy is controlled so as to be interrupted by said image recording pulse signal is so produced that the rear end of the recording pulse signal of the preceding recording side pixel in a pair of pixels adjacent to an arbitrarily selected pixel in the recording scanning direction (x, y) is in accordance with the rear end of said arbitrarily selected pixel and the front end of the recording pulse signal of the succeeding recording side pixel is in accordance with the front end of said arbitrarily selected pixel.
- 5. A pixel recording pulse signal generation method, by which an intermediate chrominance is printed by effecting area-modulation by means of colored inks of at least one color (C, M, Y) within a pixel, which is the smallest unit region of spatially quantized image data, comprising at least the following steps:

effecting an area-modulation by arranging a first colored ink of at least one color (C. M. Y) at a first-position within a pertinent pixel, and

effecting another area-modulation by arranging a second-colored ink of at least one color (C, M, Y) at a second position within said pixel.

6. A pixel recording pulse signal generationmethod, according to Claim 5, wherein said first colored ink is arranged from one end within the pixel towards the center of the pixel and said second colored ink is arranged from another end within the pixel towards the center of the pixel.

- 7. A pixel recording pulse signal generation method, according to Claim 4, wherein said one end and said another end are one end and the other end in the main scanning direction within the pixel.
- 8. A pixel recording pulse signal generation method according to Claim 5, wherein said first colored ink is constituted by a multi-layer structure consisting of yellow ink, magenta ink and cyan ink and said second colored ink is constituted by black ink.
- 9. A pixel recording pulse signal generation method, according to Claim 6, wherein in an arbitrarily selected pixel, said first colored ink is arranged from one end within the pixel towards the centre of the pixel and said second colored ink is arranged from another end within the pixel towards the center of the pixel, and further said second colored ink is arranged from said another end within the pixel towards the center of the pixel and said first colored ink is arranged from said one end within the pixel towards the center of the pixel.
 - 10. A scanning recording type printing device comprising:
 - a memory means (1) memorizing depth data signals (DA) for one scanning line;
 - a means (10, 12, 13, 14, 15) including a clock generator (10) and a counter (13) and producing a comparison data signal (DB) formed by repeating an up counting operation and a down counting operation for every pixel, which is the smallest unit region of an image;
 - a means (5, 9) generating a pixel recording pulse signal (S), comparing said depth data (DA) with said comparison data signal (DB);
 - a semiconductor laser circuit (6) producing laser light based on said inputted pixel recording signal (S);
 - a means (7,-8) recording an image corresponding to-said pixel recording pulse signal (S) on a recording medium by sweeping said laser light; and
 - a timing treatment means (4) controlling the operation of said memory means (1), said comparison data production means (10, 12, 13, 14, 15), said pixel recording pulse signal production means (5, 9) and said image recording means (7, 8).
 - 11. A scanning recording type printing device according to Claim 10, having a counter (11) and a monostable multivibrator (16); further comprising a means (11, 16) controlling the screen angle, by controlling said means (10, 12, 13, 14, 15) producing a comparison data signal (DB).

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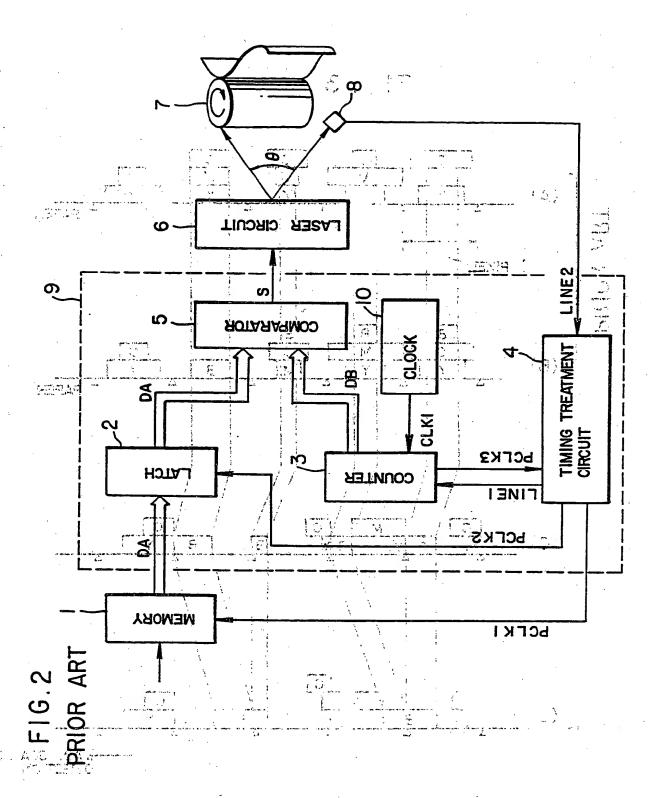
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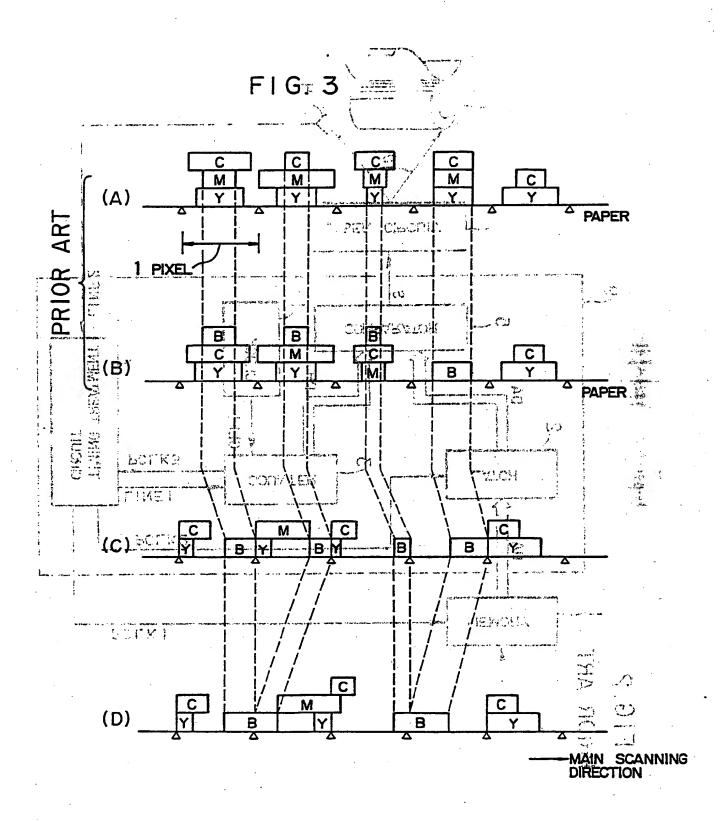
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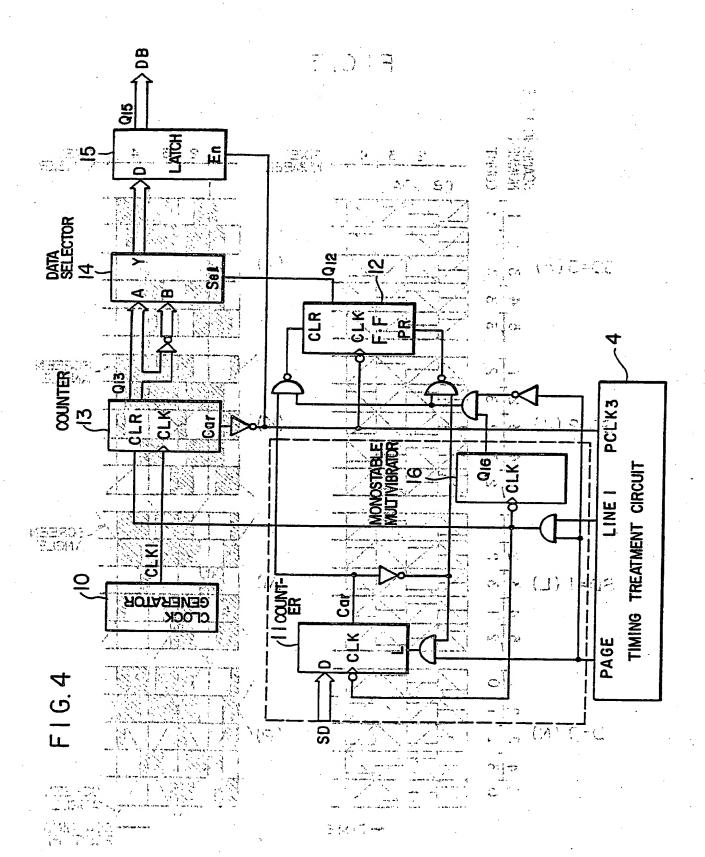
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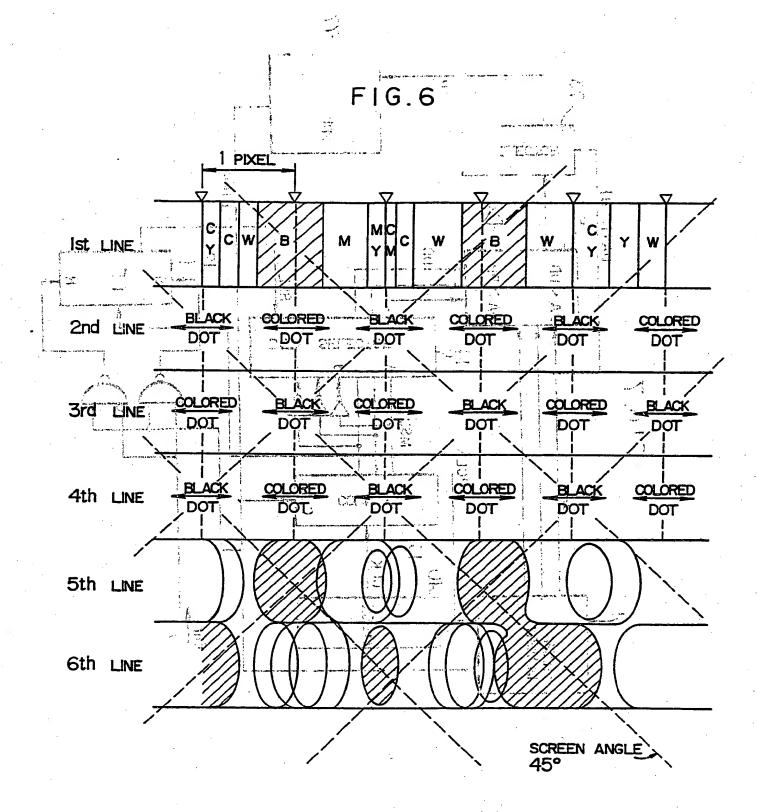
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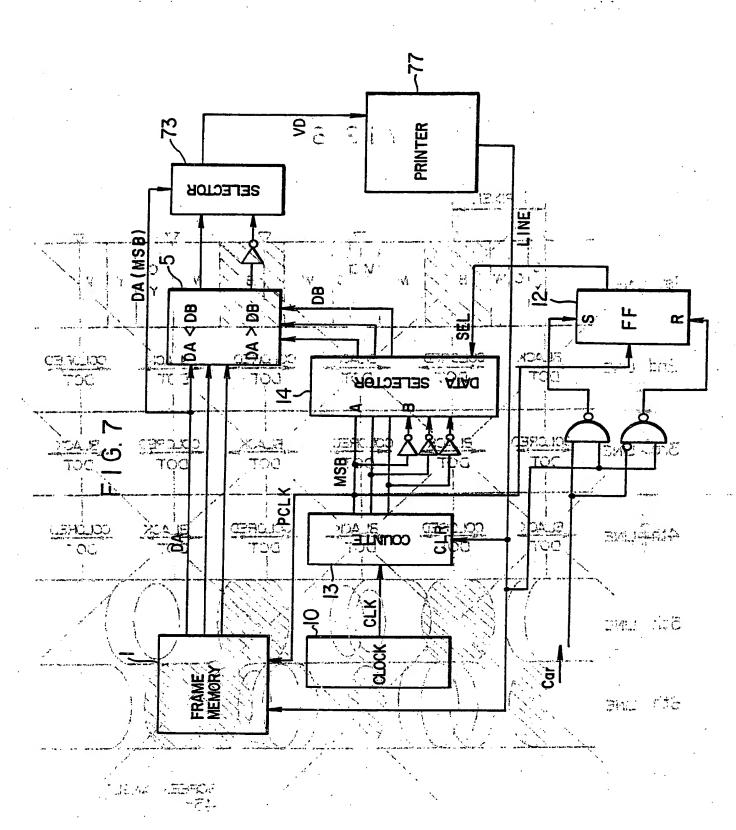
SCANNING POSITION

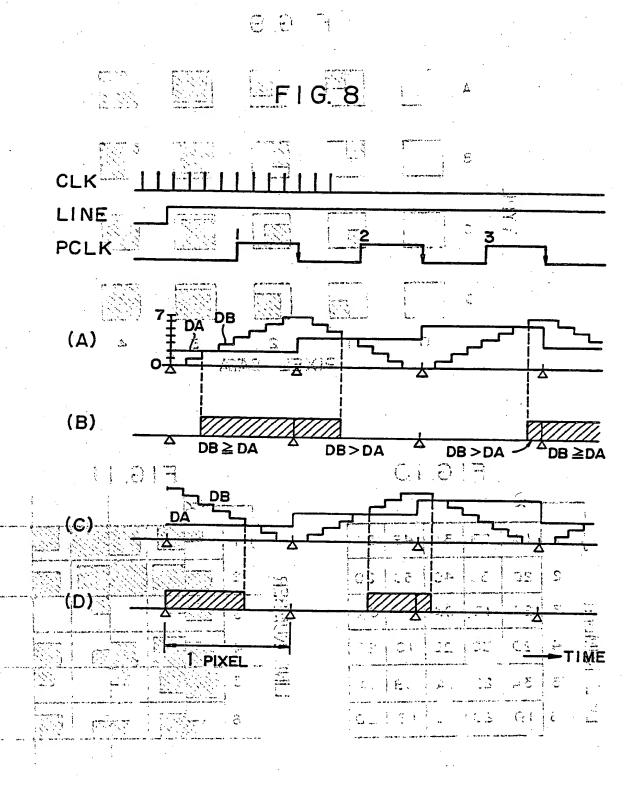
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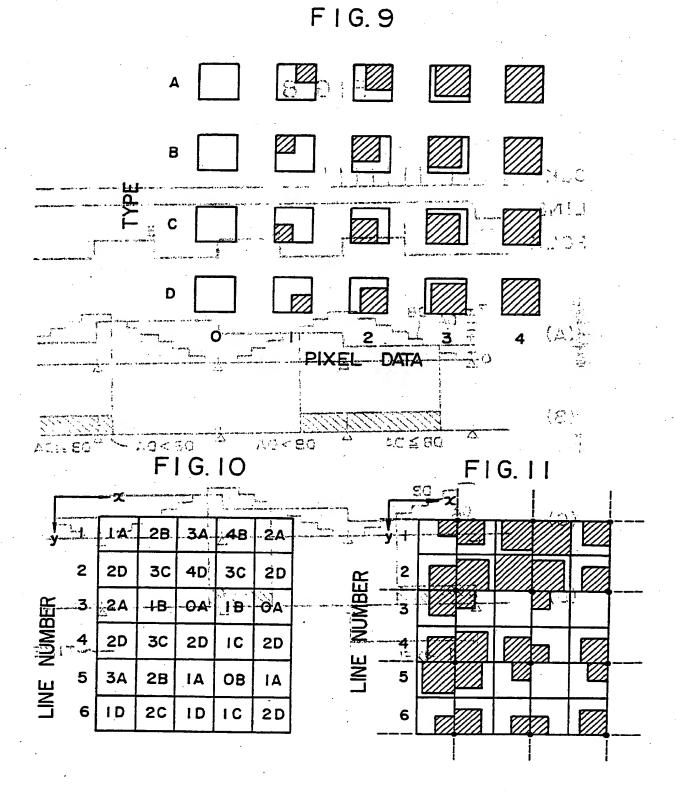
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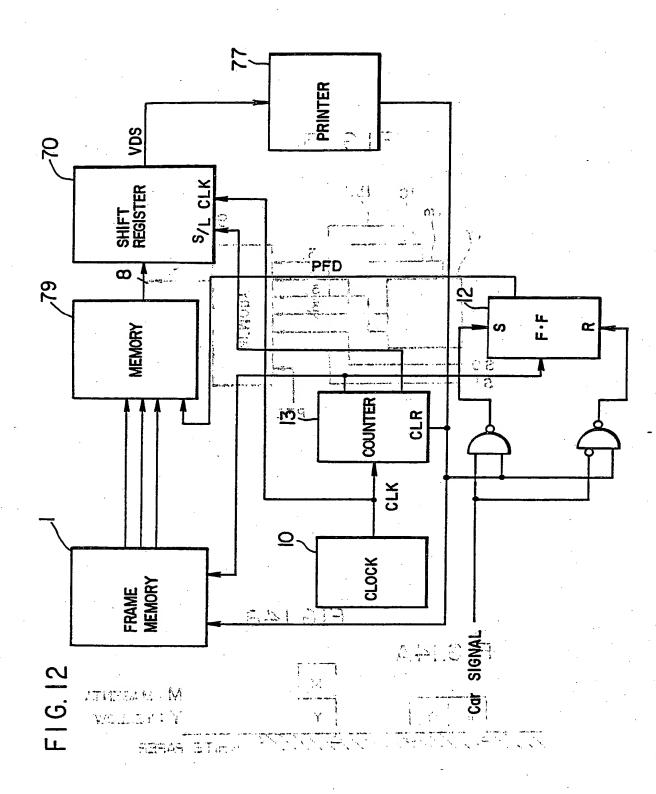


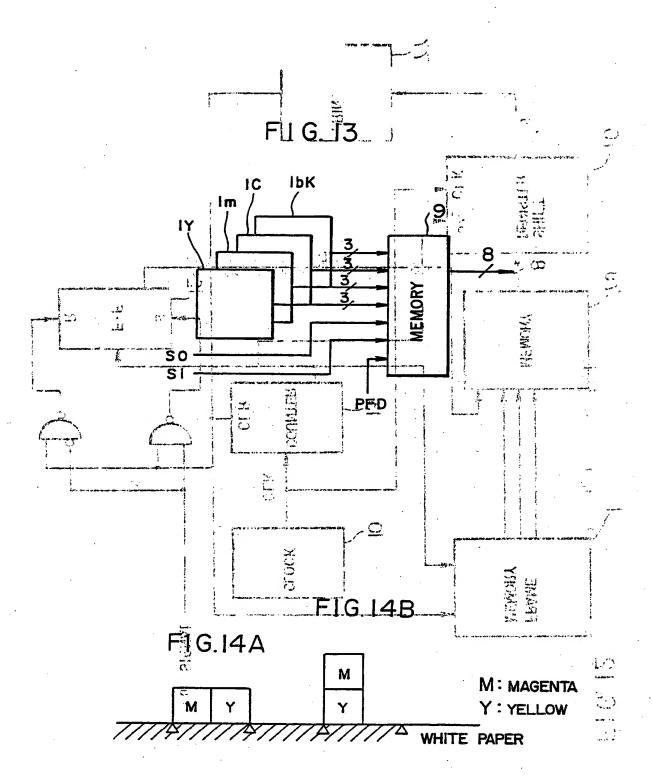




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11 Publication number:

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(51) Int. Cl.4: H04N 1/40 , H04N 1/46

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- 71 Applicant: HITACHI, LTD. 6, Kanda Surugadai 4-chome Chiyoda-ku Tokyo 100(JP)
- 2 Inventor: Kobayashi, Shin'ya 2467 Motoyoshidacho Mito-shi(JP) Inventor: Anzai, Masayasu 20-8 Kanesawacho 5-chome Hitachi-shi(JP)

FIG. I

- Representative: Strehl, Schübel-Hopf, Groening, Schulz Widenmayerstrasse 17 Postfach 22 03 45 D-8000 München 22(DE)
- Scanning recording type printing method and apparatus for realizing the same.
- (S) A scanning recording type printing method, by which a pixel recroding pulse signal (S) is produced by comparing a comparison data signal (DB), which is formed by repeating an up counting operation and a down counting operation for every pixel, which is the smallest unit region of an image, with a depth data signal (DA) for one scanning line and the location of each of net points of at least one color printed within a pixel is controlled by the pixel recording pulse signal (S) so that worsening of the image quality in a high precision fine image printing can be reduced.

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EUROPEAN SEARCH REPORT

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Application Number

86 10 4403 ΕP

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Category	of relev	ant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 4)	
, Υ	DE-A-3 338 722 * Page 13, line	(VICTOR CO. OF JAPAN) 8 - page 16, line 7 *	1-4	H 04 N 1/40 H 04 N 1/46	
Y	GB-A-2 102 240 * Page 3, line	(DAINIPPON) 11 - page 4, line 15 *	1-4		
Х	US-A-3 230 303 * Column 5, line	(MACOVSKI) e 69 - column 7, line 29	5-7		
Y A			8,9 .		
Υ.	142 (M-146)[1020	OF JAPAN, vol. 6, no.], 31st July 1982; & CANON K.K.) 19-04-1982	8,9		
Y	US-A-4 040 094 * Column 8, line *	(EVERETT) 53 - column 9, line 2	10,11		
	US-A-4 384 297 * Column 2, line	(OHARA) s 50-63 *	10,11	TECHNICAL FIELDS SEARCHED (Int. Cl.4)	
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	The present search report l	nas been drawn up for all claims	-		
THE	Place of search HAGUE	Date of completion of the search 10-02-1988	DE RO	Examiner DECK A.F.A.	

EPO FORM 1503 03.82 (P0401)

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